# Kankichi SOHMA*: Pollen morphology of the Japanese species of *Utricularia* L. and *Pinguicula* L. with notes on fossil pollen of *Utricularia* from Japan (2)**

# 相馬寛吉*: 日本産タヌキモ属およびムシトリスミレ属の花粉形態とタヌキモ属の化石花粉について (2)**

**Utricularia racemosa** Wallich, Cat. No. 1496, 1829. (Figs. 38–39).

Voucher Specimen: Mobara, Kazusa; J. Ohwi & T. Koyama, Aug. 23, 1953, TUS 5912; Slide No. 1981.

Compare: *U. racemosa*, Ikuse, 1956, p. 136. *U. caerulea* (=*racemosa*), Thanikaimoni, 1966, p. 272, pl. 3, figs. 5–6. *U. racemosa*, Huynh, 1968, p. 17, 25, figs. 2–4. *U. racemosa* Huang, 1972, p. 156–157, pl. 98, figs. 21–23.

Description: Pollen grains tricolporate; mostly suboblate, occasionally oblate or oblate spheroidal in equatorial view; size P: 20.5–26.5×E: 25.0–30.5 $\mu$, average P: 22.6×E: 27.8 $\mu$ in diameter; circular in polar view; furrows meridional, long, reaching to almost near poles, widely open without constriction at equator, without marginal thickening, intruding strongly, margin jagged, apex blunt, membrane smooth; pores circular to ellipsoidal with longer axis elongated longitudinally, P: 4.5–8.0×E: 4.6–6.5 $\mu$ in diameter, margin jagged without thickening, membrane smooth; exine tectate, about 1.5 $\mu$ thick uniformly, decreasing slightly in thickness towards furrow margins, ektexine more or less thicker than endexine; exine ornamentation psilate.

Remarks: According to Ikuse (1956) and Huang (1972) the grains of this species have fine reticulation.

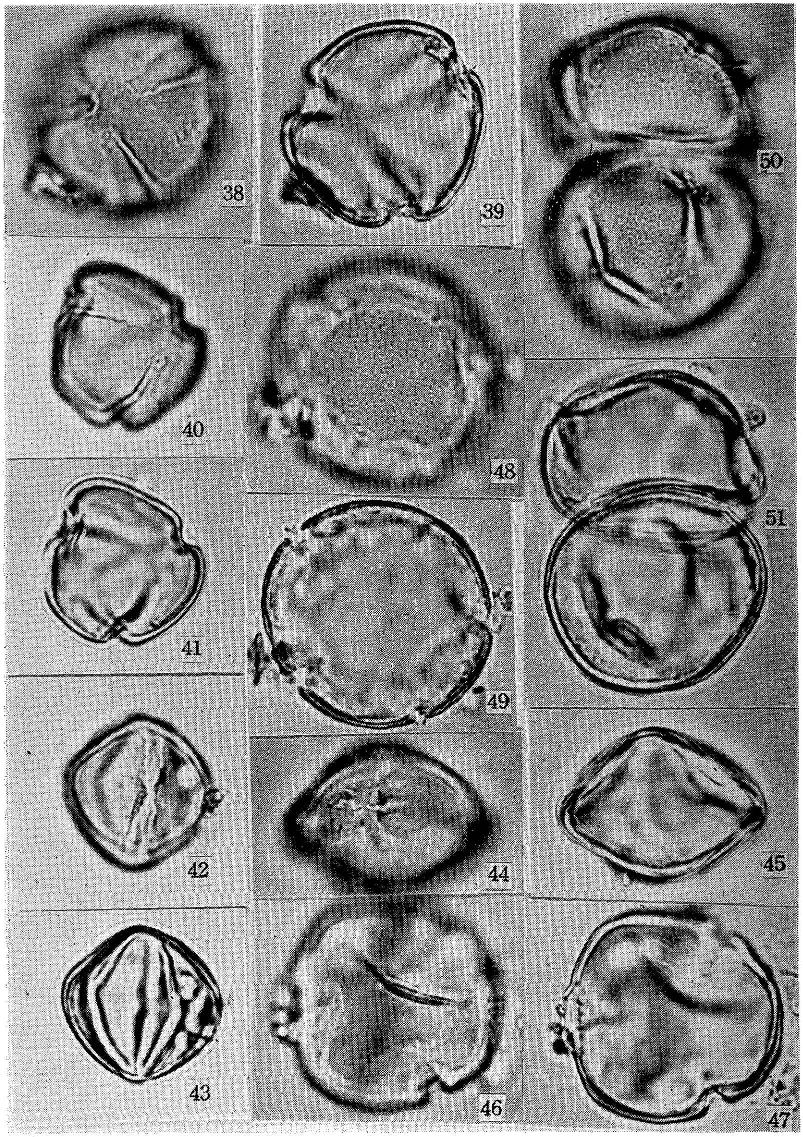
**Utricularia nipponica** Makino, Bot. Mag. Tokyo **20**: 95, 1906. (Figs. 40–43).

Voucher Specimens: Tenpaku-moor, Toyohashi, Mikawa; S. Komiya, Aug. 26, 1973, NDC; Slide No. 2178. Tenpaku-moor, Toyohashi, Mikawa; S. Komiya, Aug. 13, 1967, NDC 2195; Slide No. 2179.

---

* Biological Institute, Tohoku University, Sendai. 東北大学理学部生物学教室.

** This study is partly supported by a Grant in Aid for Fundamental Scientific Research by the Ministry of Education of Japan, No. 748012.
Continued from Journ. Jap. Bot. **50**: 164-179.



Figs. 38-39. *Utricularia racemosa* Wallich. Slide no. 1981. ×1000. Figs. 40-43. *Utricularia nipponica* Makino. Figs. 40-41, Slide no. 2179. ×1000, Figs. 42-43, Slide no. 2178. ×1000. Figs. 44-47. *Utricularia bifida* L. Slide no. 1984. ×1000. Figs. 48-51. *Utricularia affinis* Wight. Slide no. 1983. ×1000.

Description: Pollen grains tricolporate; suboblate to oblate or prolate spheroidal to subprolate in equatorial view; size P: 17.0–19.0×E: 20.0–20.5 μ or P: 19.5–25.0×E: 17.5–19.8 μ, average P: 17.8×E: 20.2 μ or P: 22.1×E: 18.8 μ in diameter; circular in polar view; furrows meridional, long, reaching almost to near the poles, widely open, sometimes more or less constricted at equator, without or slightly marginate, intruding strongly, margin jagged, apex acute to blunt, membrane smooth to minutely granulated; pores circular to ellipsoidal with longer axis elongated equatorially, P: 2.0–2.5×E: 2.5–3.5 μ in diameter, margin jagged without thickening, membrane smooth; exine tectate, about 1–1.5 μ thick, decreasing slightly in thickness towards furrow margins, ektexine thicker than endexine; exine ornamentation psilate.

Remarks: Two different collections of *U. nipponica* both from the same locality exhibit no extensive pollen morphological variations except for the shape in equatorial view. The area of distribution is restricted to Japan.

**Utricularia bifida** L., Sp. Pl. 18, 1753. (Figs. 44–47).

Voucher Specimen: Mobara, Kazusa; J. Ohwi & T. Koyama, Aug. 23, 1953, TUS 5953; Slide No. 1984.

Compare: *U. bifida*, Ikuse, 1956, p. 136, pl. 36, fig. 14. *U. bifida*, Thanikaimoni, 1966, p. 274, pl. 3, figs. 9–10. *U. bifida*, Huynh, 1968, p. 29. *U. bifida*, Huang, 1972, p. 156, pl. 98, figs. 11–14.

Description: Pollen grains mostly tricolporate, rarely tetracolporate; mostly oblate, occasionally suboblate in equatorial view; size P: 20.0–25.0× E: 26.5–31.0 μ, average P: 22.0×E: 28.0 μ in diameter; circular in polar view; furrows meridional, medium in length, more or less open, constricted and protruding at equator, without marginal thickening, more or less flat or intruding slightly, margin jagged, apex often acute, membrane smooth to minutely granulated; pores circular, about 5 μ in diameter, delimitation obscure; exine tectate, about 1 μ thick, decreasing more or less in thickness towards furrow margins, ektexine slightly thicker than endexine, columellae simple, minute; exine ornamentation psilate.

Remarks: According to Ikuse (1956) and Huang (1972), this species has fine reticulate exine ornamentation. A scabrate exine of this species is reported by Thanikaimoni (1966).

**Utricularia affinis** Wight, Hook. Kew Journ. I: 373, 1849. (Figs. 48–51).

Syn.: *U. yakusimensis* Masamune in Fl. & Geob. Yakushima 409, 1934.—Hara in Journ. Jap. Bot. **17**: 122, 1941.—Hara in Enum. Sperm. Jap. **1**: 293, 1949.—Tamura in Acta Phyt. Geob. **15**: 32, 1953.—Ohwi in Fl. Jap. 814, 1965.

Voucher Specimen: Ôjôji, Rikuzen; S. Sugaya & C. Kimura, Aug. 26, 1954, TUS 5894; Slide No. 1983.

Compare: *U. yakusimensis*, Ikuse, 1956, p. 136. *U. uliginosa* (=*affinis*), Thanikaimoni, 1966, p. 272, pl. 3, figs. 7-8. *U. affinis*, Huynh, 1968, p. 29. *U. affinis*, Huang, 1972, p. 156, pl. 98, figs. 1-4.

Description: Pollen grains mostly tricolporate, occasionally tetracolporate or pentacolporate; often suboblate to oblate, rarely oblate spheroidal in equatorial view; size P: 12.5-23.5×E: 20.5-29.5 μ, average P: 19.4×E: 24.7 μ in diameter; circular in polar view; furrows meridional, medium in length, slightly open, constricted at equator, without marginal thickening, more or less flat or intruding slightly, apex acute, membrane obscure; pores circular, about 5 μ in diameter, delimitation obscure; exine tectate, about 1.0-1.5 μ thick, more or less uniform in thickness or decreasing slightly in thickness towards furrow margins, ektexine slightly thicker than endexine; exine ornamentation psilate to scabrate or very fine faintly reticulate.

Remarks: Grains of the tetracolporate and/or pentacolporate types are generally a little larger in size than those of the tricolporate type.

**Pinguicula vulgaris** L., Sp. Pl. 17, 1753. (Figs. 52-56).

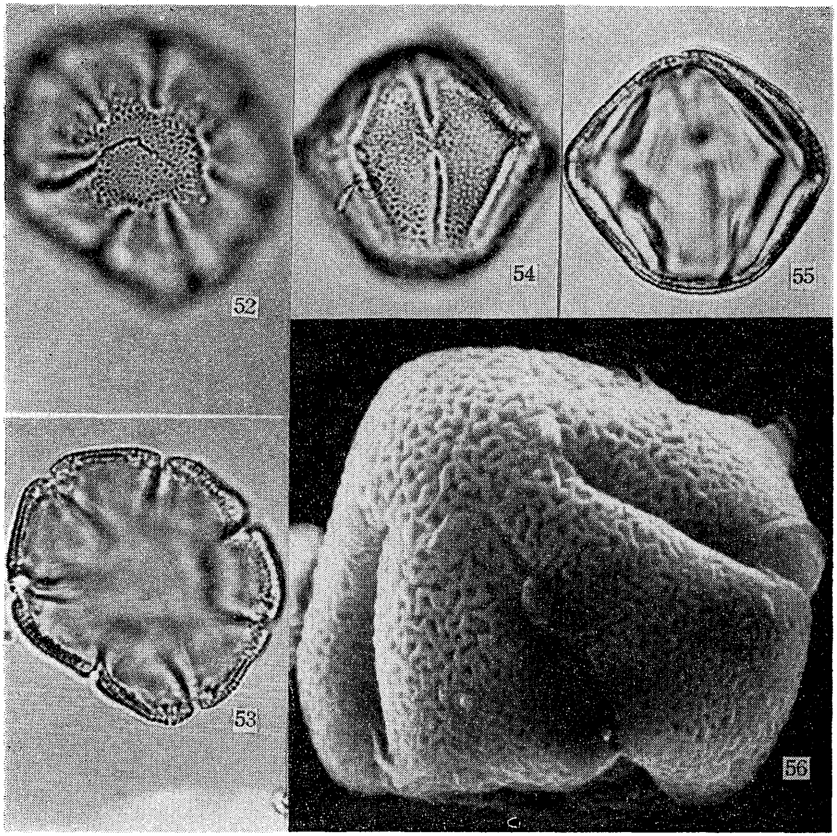
Syn.: *P. vulgaris* L. var. *macroceras* (Pall. ex Link) Herder in Acta Horti Petrop. **1**: 380, 1872.—Makino in Bot. Mag. Tokyo **10**: 26, 1896.—Kudo in Fl. Param. 159, 1922.—Hara in Enum. Sperm. Jap. **1**: 291, 1949.—Ohwi in Fl. Jap. 816, 1965.

Voucher Specimen: Gentamori-Hachiman numa, Hachimantai, Ugo; S. Kurosawa, July 20, 1953, as *P. vulgaris* var. *macroceras* f. *albiflora* in TI; Slide No. 2033.

Compare: *P. vulgaris* var. *macroceras*, Ikuse, 1956, p. 136, pl. 36, fig. 12. *P. vulgaris*, Erdtman, Berglund & Praglowski, 1961, p. 37 & 83, pl. 36, figs. 1-2. *P. vulgaris*, Nilsson & Praglowski, 1964, p. 60.

Description: Pollen grains stephanocolporate; shape much varied, mostly oblate spheroidal to suboblate or prolate spheroidal, occasionally oblate or subprolate in equatorial view; size P: 22.0-26.5×E: 24.0-34.0 μ or P:

26.0–30.0×E : 23.0–26.5 μ, average P : 24.4×E : 28.7 μ or P : 27.9×E : 24.6 μ in diameter; polygonal in polar view; furrows meridional, long, almost reaching to poles, 5–8 in number, narrowly open, intruding strongly, constricted at equator, jagged margin about 1.5 μ broad, apex often acute, membrane obscure; pores ellipsoidal with longer axis elongated equatorially, about P : 2×E : 6 μ in diameter, without marginal thickening, membrane obscure; exine tectate, about 2 μ thick, almost uniform or increasing slightly in thickness towards furrow margins, ektexine obviously thicker than endexine, columellae simple, minute and distinct; exine ornamentation faintly reticulate.



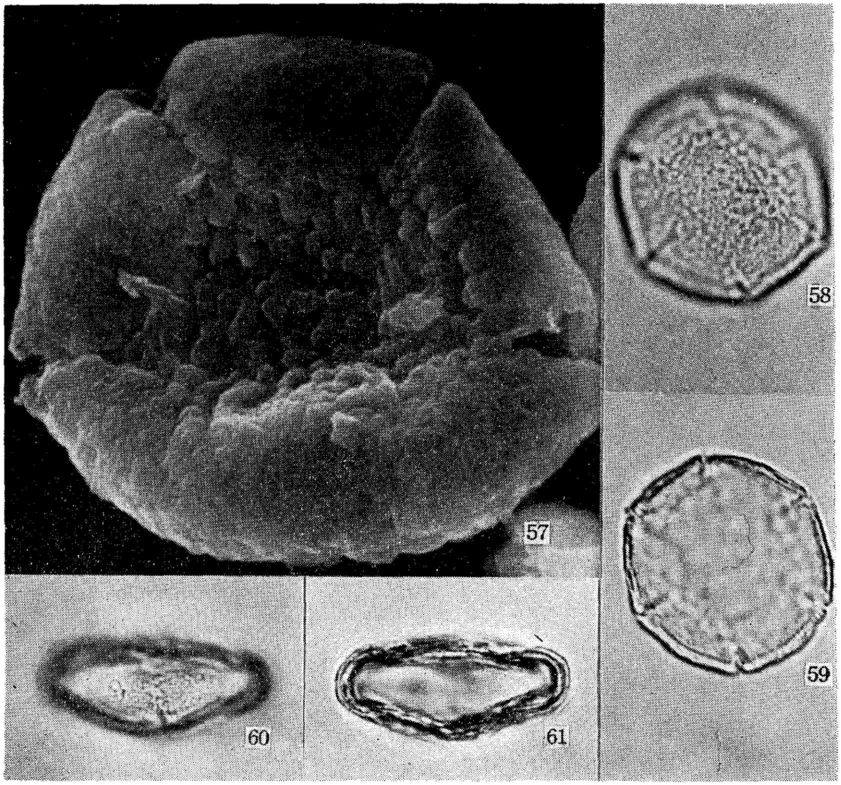
Figs. 52–56. *Pinguicula vulgaris* L. Slide no. 2033. Figs. 52–55, ×1000. Fig. 56, ×2200.

Remarks: The grains described here and those described by previous workers do not exhibit any extensive pollen morphological variations except for the relatively larger size of the grains recorded by them. Under the SEM, the surface of the exine is provided as a rule with fairly irregular reticulate to rugulate ornamentation with the width of the muri exceeding that of the lumina.

**Pinguicula ramosa** Miyoshi, Bot. Mag. Tokyo 4: 315, t. 11, 1890. (Figs. 57-61).

Voucher Specimen: Karasawa, Mt. Nyoho, Kozuke; K. Jyô; date unknown, TI; Slide No. 2032.

Description: Pollen grains stephanocolporate; mostly oblate, rarely



Figs. 57-61. *Pinguicula ramosa* Miyoshi. Slide no. 2032. Fig. 57, ×2600. Figs. 58-61, ×1000.

suboblate to oblate spheroidal in equatorial view; size P: 12.5–18.0×E: 18.5–26.0 μ, average P: 15.7×E: 21.6 μ in diameter; rounded-polygonal in polar view; furrows meridional, short to medium in length, 5–6 in number, narrowly open, intruding strongly, constricted at equator, margin jagged, apex acute to often blunt, membrane minutely granulated; pores ellipsoidal with longer axis elongated meridionally, about P: 2.0–2.5×E: 2.5–3.0 μ in diameter, slightly marginated, membrane obscure; exine tectate, about 1–1.5 μ thick, almost uniform or slightly increasing in thickness towards pole areas and pore margins, ektexine more or less thicker than endexine, columellae simple, minute and distinct; exine ornamentation weakly verrucate with spaced verrucae on polar areas, almost psilate to scabrate on equatorial area.

Remarks: This is an endemic species to Japan and is very rarely found as an epiphyte on wet shaded rocky cliffs in mountains around Nikkô. Under the SEM, the surface of the exine on the equatorial area is not smooth, but faintly pebbled in terms of microverrucate.

## Fossil pollen records

There are only few reports of fossil grains referrable to those of the modern *Utricularia* from the pre-Quaternary epoch. Ramanujam (1966) described a new species from the Miocene lignite of the South Arcot district, Madras, India, under the name of a new form genus, *Neyvelipollenites psilatus*. He compared this new species with the pollen of *Utricularia*. Zagwijn (1960) studied the fossil pollen from the Pliocene sediments of the Netherlands and reported pollen bearing a close resemblance to that of the modern *Utricularia*.

Pollen grains of *Utricularia* are known from many Pleistocene and Holocene stations (Halden, 1917; *U. vulgaris*, Jonas, 1952; *U.* cf. *intermedia* and *U.* cf. *vulgaris*, Iversen, 1954; Erdtman, 1954; Godwin, 1956; Zagwijn, 1960; Nakamura and Tsukada, 1960; *U. minor*, Thanikaimoni, 1966; Bartlett and Barghoorn, 1973). Besides these, Kamienski (1895) cited the fossil record of *U. Berendtii* from the Quaternary sediments in northern Germany.

Fossil pollen of *Pinguicula* have been recorded only by Mitchell (1954) from the Late-Glacial sediments in Ireland. The time of origin of *Utricularia* is not known, but it is quite possible that the fossil pollen of

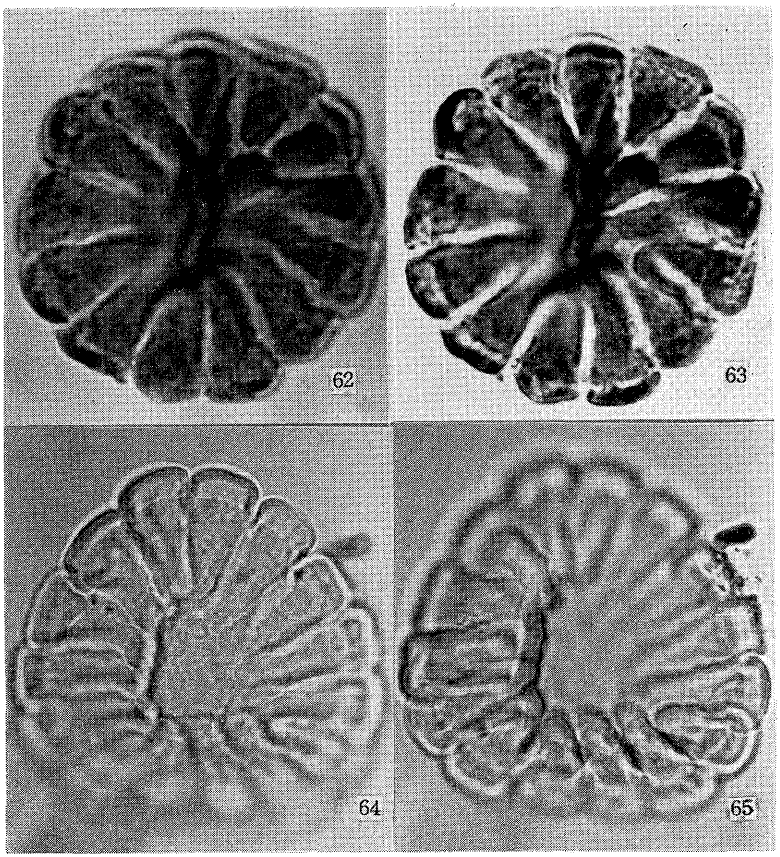
*Utricularia* lies widely undiscovered in the pre-Quaternary sediments both of the New World and Old World.

In his palynological study of the samples from archaeological sites, Mı. Y. Yasuda, one of the graduate students of the Institute of Geography, Tôhoku University, identified many fossil pollen grains and spores. The assemblage is dominated by angiospermous pollen comparable to some members of the Fagaceae, Juglandaceae, Gramineae and Cyperaceae, associated with some aquatic Angiosperms. Among the aquatic Angiosperms including pollen of *Menyanthes*, the author's attention was directed to a single characteristic pollen comparable to that of *Utricularia* during a re-examination of many sets of fossil single-grain specimens picked up by Mr. Y. Yasuda. A little later after finding this interesting grain, an additional grain was recovered from the same sample by Mr. S. Tsuji, a student at the Institute of Applied Earth Sciences, Nihon University.

Based on the pollen morphology of the Japanese species of *Utricularia* given in the preceding chapter, the author reports on whether the morphological features of pollen permit specific identification within the Japanese members of *Utricularia*.

The silt-clayey sample in which the fossil grains of *Utricularia* were recovered was obtained from a bore hole drilled near the southern bank of the river Nikkô-gawa in the Shônai district, some 3 km from the mouth, Yamagata Prefecture, northeast Japan. Pieces of woods both from the lower and the upper parts of the mentioned sample were submitted for radiocarbon datings to Dr. Kigoshi (Survey nos. Gak-4577 and Gak-4578). His results gave ages for the former of 3,090 years B. P. and for the latter of 6,040 years B. P.

The fossil pollen grains of *Utricularia* (Figs. 62–65) are stephanocolporate, with a fused transverse furrow at the equatorial girdle, simply referred sometimes to as "zonorate" or "synorate"; probably suboblate to oblate spheroidal in equatorial view; size P: 30.0–40.0×E: 34.4–46.4 $\mu$ in diameter; circular to rounded-triangular in polar view; furrows meridional, long, almost reaching to the poles, narrowly open, 13–15 in number, without marginal thickening, intruding strongly, apex acute to blunt, confluent sometimes at apices, membrane obscure; a transverse furrow on the equatorial girdle running zonally or slightly oblique with psilate ektexine dis-



Figs. 62-65. Fossil pollen grains of *Utricularia* ×1200.

tinctly loosened from the endexine, often referred to as "cavate", about 5-10 μ high, without prominent margins; exine tectate, about 3-4 μ thick, ektexine much thicker than endexine, columellae simple, about 1 μ high, distinct; exine ornamentation psilate to scabrate. Slides with fossil pollen are preserved in the Biological Institute, Tôhoku University.

These characters of the fossil pollen grains are also present and common to some of the modern species of *Utricularia*, especially to the grains of *U. vulgaris*, although they possess much thicker exine and larger grain size than the modern reference pollen. The part of the assemblage of pollen and spores represented by *Alnus*, *Fagus*, *Pterocarya*, *Tilia*, *Typha*, *Menyanthes*, *Botryococcus*, etc., suggests that the sediments were deposited in a temperate to cool temperate swampy environment comparable to the present lowland swamps in northeast Japan.

## Discussion and conclusion

De Candolle (1844) defined " Ordo CXIX. Lentibularieae ", and recognized three genera, viz. *Utricularia*, *Genlisea* and *Pinguicula*. The genus *Utricularia* was divided by him into five sections, viz. Megacista, Lentibularia, Stylotheca, Oligocista and Orchidioides. The genus *Pinguicula* was split into three sections, viz. Orcheosanthus, Pinophyllum and Brandonia.

The Lentibulariaceae have been treated in various way by different authors. Benjamin (1847) recognized six genera and split *Utricularia* into 11 sections. Kamienski (1895) divided the family into two tribes, viz. Utricularieae and Biovularieae. The genus *Utricularia* was subdivided into ten sections. Barnhart (1916) recognized 16 genera in the family. Recently Komiya (1973) divided the family into three subfamilies, viz. Pinguiculoideae, Genliseoideae and Utricularioideae. The last-mentioned subfamily was further divided into two tribes, i. e. Utricularieae and Biovularieae. The genus *Utricularia* was subdivided into 8 subgenera. Thus the genus *Utricularia* consisting of a comparatively large number of species, has not yet been standardized taxonomically.

Based on the present pollen morphological investigation, although the materials are concerned only with the members distributed in Japan, two distinct major types are encountered in *Utricularia*; one is tricolporate, e. g. *U. racemosa*, *U. nipponica*, *U. bifida* and *U. affinis*, the other is stephanocolporate, e. g. *U. vulgaris*, *U. dimorphantha*, *U. intermedia*, *U. minor*, *U. aurea* and *U. gibba*. The species forming Sect. Oligocista DC. have principally tricolporate pollen grains and those forming Sect. Lentibularia Gesn. *sensu* DC (1844) have stephanocolporate ones. Huynh (1968) distinguished five pollen morphological groups by his study on extensive material of the genus *Utricularia*. The ten sections of *Utricularia* subdivided by Kamienski (1895) are either homomorphs or heteromorphs palynologically as pointed out by Huynh (1968). For this reason the palynotaxonomy of this genus requires further study in co-operation with taxonomists to elucidate the proper systematic status.

Sect. Lentibularia Gesn. of the Japanese *Utricularia* is thought to be palynologically heterogeneous. *U. vulgaris*, *U. dimorphantha* and *U. minor* are similar with regard to general pollen morphology. *U. intermedia* differs from all others in respect to pollen morphology. This species with a more northerly distribution than the others has grains that are of verrucate to rugulate exine ornamentation with wrinkles parallel to transverse lines on the intercolpia. *U. aurea* and *U. gibba* subsp. *exoleta* have pollen grains that resemble each other with regard to the verrucate exine ornamentation and much confluent furrows at the polar areas, but are quite different from one another in grain size and in number of furrows.

For normally developed grains the main differences can be outlined as shown in the following key:

Pollen key to the Japanese species of the Lentibulariaceae based
on acetolyzed pollen grains mounted in silicone oil

- A. Pollen grains tricolporate
  - B. Exine fine reticulate ................................... *Utricularia affinis*
  - BB. Exine psilate
    - C. Equatorial diameter generally>20 μ
      - D. Furrows long, almost reaching polar areas .......... *U. racemosa*
      - DD. Furrows±medium in length ................................ *U. bifida*
    - CC. Equatorial diameter<20 μ .......................... *U. nipponica*
- AA. Pollen grains stephanocolporate
  - B. Furrows<8 in number
    - C. Exine fine reticulate ........................... *Pinguicula vulgaris*
    - CC. Exine faintly verrucate in polar area .......... *Pinguicula ramosa*
  - BB. Furrows>10 in number
    - C. Exine verrucate to rugulate in polar areas
      - D. Exine wrinkles on intercolpia ....................................
        ...................... *U. intermedia* & *U. intermedia* f. *ochroleuca*
      - DD. Not so
        - E. Furrows<16 in number ..................... *U. gibba* ssp. *exoleta*
        - EE. Furrows>16 in number ........................... *U. aurea*
    - CC. Exine psilate to scabrate in polar areas

D. Exine psilate
  E. Furrows open ............................*U. gibba* ssp. *gibba*
  EE. Furrows narrow ......*U. vulgaris* & *U. vulgaris* f. *tenuicaulis*
DD. Exine scabrate
  E. Pores arranged ± obliquely ...........................*U. minor*
  EE. Pores arranged zonally .......................*U. dimorphantha*

Although *U. intermedia* is distinct and differentiated from the others, this species probably belongs to the same group of the genus derived from a common line. *U. vulgaris* may perhaps be the most primitive member in the series. The pollen grains have mostly psilate exine ornamentation with a transverse furrow in the equatorial girdle running zonally. The meridional furrows are less frequently confluent at their apices. These characters are quite similar to those of the fossil grains. The exine pattern becomes progressively coarser in the sequence, ending in the characteristic pattern of *U. intermedia* with an obliquely transverse furrow and much confluent meridional furrows, which are considered to be more advanced characters. There are characters transitional between these extremes. On the basis of these main pollen features a tentative phylogenetic outline is roughly drawn as follows:

*U. vulgaris* → *U. dimorphantha* → *U. minor* → *U. aurea* → *U. gibba* subsp. *exoleta* → *U. intermedia*

Of all the specimens examined only three, viz. *U. gibba* subsp. *exoleta* (Iriomote, Amano, TNS), *U. intermedia* (Shiriya-zaki, Ohashi, TUS) and *U. intermedia* f. *ochroleuca* (Hakkôda, Sugaya & Ômiya, TUS), showed a wide range of variation in size. The frequencies of occurrence of the aberrant forms of pollen were also quite high. Whether this feature is due to incidental circumstances merely by the choice of materials, or to a reflection with reference to the hybrid nature of the specimens of these species is not yet clear. These suggestions, however, are very tentative because of the limited number of specimens compared. It is of interest to note that hybridization has frequently been suggested between the species of *Utricularia* (Ceska and Bell, 1973).

With the exception of fine reticulate exine ornamentation in *U. affinis*, the investigated species belonging to Sect. Oligocista DC. are closely related each other palynologically. The tricolporate type of grains with psilate exine pattern is the feature that is exclusively confined to this section, although occasional tetra- or pentacolporate grains in *U. affinis* or *U. bifida* are noticeable.

In the genus *Pinguicula* the two Japanese species are well differentiated from each other with regard to exine ornamentation, leading to the recognition of at least two pollen subtypes in the genus, although the taxonomic significance of the character is not yet clear.

## Summary

Pollen morphological descriptions are given for the 15 Japanese members within the Lentibulariaceae. The pollen types are related to the subdivisions recognized in the family and are generally found to support the De Candolle's system among the existing classifications. Of the members in Sect. Oligocista DC., *U. racemosa, U. nipponica, U. bifida* and *U. affinis* have grains that are principally tricolporate with psilate exine ornamentation. Among the members in Sect. Lentibularia Gesn., *U. vulgaris, U. vulgaris* f. *tenuicaulis, U. dimorphantha, U. intermedia, U. intermedia* f. *ochroleuca, U. minor, U. aurea, U. gibba* subsp. *gibba* and *U. gibba* subsp. *exoleta* have grains that are stephanocolporate with a transverse furrow in the equatorial girdle. Their exine ornamentation, number and feature of the meridional furrows are much varied from species to species or even within a certain species.

The fossil grains described from the Holocene sediments are comparable morphologically with those of *U. vulgaris*.

A pollen key to the Japanese members of the Lentibulariaceae is given. The following is a tentative phylogenetic outline within the members of Sect. Lentibularia Gesn. suggested on the basis of their main palynological characters: *vulgaris*→*dimorphantha*→*minor*→ *aurea* → *gibba* subsp. *exoleta* → *intermedia*

Two Japanese species of *Pinguicula* have stephanocolporate pollen grains. *P. vulgaris* has fine reticulate exine ornamentation, whereas *P. ramosa* has faintly verrucate exine pattern in the polar areas.

**Acknowledgements** The author is indebted to the directors and the curators of the herbaria mentioned in the preceding chapter for their kind permission to collect polliniferous material from their collections. Sincere thanks are due to Dr. Tadashi Komiya, Department of Biology, Nippon Dental College, who has responded to the author's request for the pollen material of *U. nipponica*, and also for his valuable informations. The author also wishes to thank Mr. Masamichi Takahashi, Biological Institute, Tôhoku University, for his technical assistance with the scanning electron microscopy. Mr. Yoshinori Yasuda, Geographical Institute, Tôhoku University, and Mr. Sei'ichirô Tsuji, Institute of Applied Earth Sciences, Nihon University, are cordially thanked for providing the fossil grains for the present study.

## Literature cited

Arber, A., 1920. Water Plants, A study of aquatic angiosperms. Cambr. Univ. Press, London, 436 p. Barnhart, J. H., 1916. Segregation of genera in Lentibulariaceae. Mem. N. Y. Bot. Gard., **6** : 39–64. ——, 1933. Pinguiculaceae, p. 1231–1238, *in* J. K. Small (ed.), Manual of the Southeastern Flora. Bartlett, A. S. and E. S. Barghoorn, 1973. Phytogeographic history of the Isthmus of Panama during the past 12,000 years—A history of vegetation, climate, and sea-level change. p. 203–299, *in* A. Graham, (ed.), Vegetation and Vegetational History of Northern Latin America. Elsevier Sci. Pub. Co., Amsterdam, 393 p. Benjamin, L., 1847. Neue Gattungen und Arten der Utricularien. Linnaea **20** : 299–320 & 485–498. Bentham, G., 1869. Lentibularieae, p. 523–533, *in* Flora Australiensis. A description of the plants of the Australian Territory. 4. Reeve & Co., London. Candolle, A. P. de, 1844. Lentibularieae, p. 2–32, *in* Prodromus System. Nat. Reg. Veget., 8. Ceska, A. and M. A. M. Bell, 1973. *Utricularia* (Lentibulariaceae) in the Pacific Northwest. Madroño, **22** : 74–84. Erdtman, G., 1952. Pollen Morphology and Plant Taxonomy—Angiosperms. Almqvist & Wiksell, Uppsala, 539 p. ——, 1954. An Introduction to Pollen Analysis. Waltham, Mass., 239 p. ——, 1969. Handbook of Palynology. An introduction to the study of pollen grains and spores. Munksgaard, Copenhagen, 486 p. ——, B. Berglund and J. R. Praglowski, 1961. An Introduction to a Scandinavian pollen flora. Grana Palyn., **2**(3) : 3–92. Faegri, K. and J. Iversen, 1950. Textbook of Modern Pollen Analysis. Munksgaard, Copenhagen, 168 p. —— and ——, 1964. Textbook of Pollen Analysis. Munksgaard. Copenhagen, 237 p. Fischer, H., 1890. Beiträge zur vergleichenden Morphologie der Pollenkörner. Breslau (Thesis), 1–72. Godwin, H., 1956. The History of the British Flora. Cambr. Univ. Press, London, 384 p. Goebel, K., 1889. Arbeiten aus dem botanischen Institut zur Marburg, IV. Der Aufbau von *Utricularia*. Flora **72**: 291–297. ——, 1891. Morphologische und biologische Studien, V. *Utricularia*. Ann. Jard. Bot. Buitenzorg **9**: 41–119. Halden, B., 1917. Om torvmossar och marina sediment inom norra Hälsinglands litorinaomrade. Sveriges Geol. Unders., Ser. C, No. 280. Heusser, C. J., 1971. Pollen and Spores of Chile. Univ. Arizona Press, Tucson, 167 p. Huang, T. C., 1972. Pollen Flora of Taiwan. Nat. Taiwan Univ. Press, Taipei, 297 p. Huynh, K. L., 1968. Étude de la morphologie du pollen du genre *Utricularia* L. Pollen et Spores **10**(1): 11–55. Ikuse, M. 1956. Pollen Grains of Japan. Hirokawa Pub. Co., Tokyo, 304 p. Iversen, J., 1954. The Late-Glacial flora of Denmark and its relation to climate and soil. Danm. Geol. Unders., II, Nr. **80**: 87–119. Jonas, Fr., 1952. Atlas zur Bestimmung rezenter und fossiler Pollen und Sporen. Feddes Repert., Beiheft **133**: 1–60. Kamienski, F., 1895. Lentibulariaceae, p. 108–123, *in* A. Engler & K. Prantl (ed.), Die Natürlichen Pflanzenfamilien. IV, 3b. Komiya, S., 1972. Exotic species of the Lentibulariaceae in Japan. Journ. Jap. Bot. **47**: 83–95, (in Japanese). ——, 1973. New subdivision of the Lentibulariaceae. Journ. Jap. Bot. **48**: 147–153. Kondo, K., 1972. A comparison of variability in *Utricularia cornuta* and *Utricularia juncea*. Amer. J. Bot. **59**: 23–37. Lloyd, F. E., 1942. The Carnivorous Plants. Ronald Press Co., N. Y., 352 p. Mitchell, G. F. 1954. The Late-Glacial flora of Ireland. Danm. Geol. Unders., II, Nr. **80**: 73–86. Nair, P. K. K., 1965. Pollen Grains of Western Himalayan Plants. Asia Pub. House, Bombay, 102 p. Nakamura, J. and M. Tsukada, 1960. Palynological aspects of the Quaternary in Hokkaido. I. The Oshima Peninsula (1). Res. Rep. Kochi Univ., Vol. 9, Nat. Sci. 1, No. **10**: 117–138, (in Japanese). Nilsson, S. and J. R. Praglowski, 1963. Pollen and spore key, p. 27–64, *in* G. Erdtman, J. R. Praglowski and S. Nilsson, An Introduction to a Scandinavian Pollen Flora. II. Almqvist & Wiksell, Uppsala, 89 p. Ramanujam, C. G. K., 1966. Palynology of the Miocene lignite from south Arcot district, Madras, India. Pollen et Spores **8**: 149–203. Shimakura, M., 1973. Palynomorphs of Japanese plants. Spec. Pub. Osaka Mus. Nat. Hist., **5**: 60 p. (in Japanese). Taylor, G., 1963. New taxa and combi-

nations in West African Lentibulariaceae and Gentianaceae. Taxon **12**: 293–294. ——, 1964. The genus *Utricularia* L. (Lentibulariaceae) in Africa (South of the Sahara) and Madagascar. Kew Bull. **18**: 1–245. Thanikaimoni, G., 1966. Pollen morphology of the genus *Utricularia*. Pollen et Spores **8**: 265–284. Zagwijn, W.H., 1960. Aspects of the Pliocene and early Pleistocene vegetation in the Netherlands. Mededelingen Geol. Stichting, Ser. C, III, 1, No. **5**: 1–78.

* * * *

邦産タヌキモ科，タヌキモ属に属する 9 種，2 亜種，2 品種と，ムシトリスミレ属の 2 種を花粉形態学的に検討した。その結果，タヌキモ属は三溝孔粒型の花粉を持つ群と，多溝孔粒型の群に分類され，De Candolle (1844) による節の分類と一致した。花粉による同定上の便宜を考え，検索表を作成した。

山形県庄内地方の沖積世堆積物から発見されたタヌキモ属の化石花粉は，その諸特徴から，タヌキモ (*U. vulgaris*) のものに一番類似点が多かった。この化石花粉，及びタヌキモ節の現生種の花粉に見られる諸形質を検討した結果，次のような系統関係が暗示された。即ち，タヌキモ→フサタヌキモ→ヒメタヌキモ→ノタヌキモ→イトタヌキモ→コタヌキモ。

ムシトリスミレ属の花粉は 2 種共多溝孔粒型であるが，外膜の模様は，ムシトリスミレでは微細な網目紋，コウシンソウは疣状紋で，両者間に明瞭な形質上の差異が認められた。

---

□石川茂雄： **津軽西海岸の植物**（青森県の自然 1）pp. 103（内 Photo 76 pp.）津軽書房，弘前 ¥3,000, 1975 年 5 月。このような局所的な表題で自然を描写した写真集が，地方の出版社から発行されたことは珍らしいが，これは自然の破壊がそれほどにさしせまって来ていることを示す一つの指標であるといえよう。著者は弘前大学理学部教授，日本海に面した津軽平野の瀕海の地，屏風山とそこに抱かれた数多くの湖沼と原野に自然を見出だし，それをひろく紹介しようとした。急速な破壊が進むにつれ，とにかく最初に出版することを余儀なくされて日の目をみたのであると著者はしるす。ページのいたるところに著者の愛する茫漠とした風物が写し出されていて，日本にもこのような処があったかと思う程である。間々にはそれを構成する植物の個有の姿が美しく収められている。解説編はこの屏風山の植生を多くの湖沼の地図を加えて説明している。東北の一隅にあるこの自然環境に注意を払われんことを希望するのは私一人ではないであろう。（前川文夫）